Resonant tunneling and the quasiparticle lifetime in graphene/ boron nitride / graphene heterostructures

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Abstract

I will present extensive microscopic calculations of the tunneling spectra in a graphene/ boron nitride/ graphene heterostructure, where the tunneling barrier is constituted by a slab of few hBN layers. In this ultra-clean heterostructure, the crystallographic misalignment between the two graphene layers provides a momentum kick to the tunneling electrons. Recent experiments [1-3] have demonstrated resonant current-voltage characteristics between highly aligned graphene layers, due to the quasi-exact conservation of in-plane momentum. The tunnel current characteristic as the misalignment angle between the graphene layers is varied is being investigated [2]. We claim [4] that this kind of experiment can be used to extract useful information on an important many-body parameter of the electron gas in graphene: the quasiparticle lifetime due to electron-electron interactions [5]. To this end, we present a theory of electron tunneling that takes into account the spectral properties of the tunneling electrons, by including quasiparticle lifetime effects into the quasiparticle spectral function and treating on an equal footing electron-electron interactions and elastic scattering off of the static disorder potential. We will provide the conditions under which tunneling spectroscopy may access the quasiparticle lifetime, against the breakdown of momentum conservation in realistic experimental situations [6].

References

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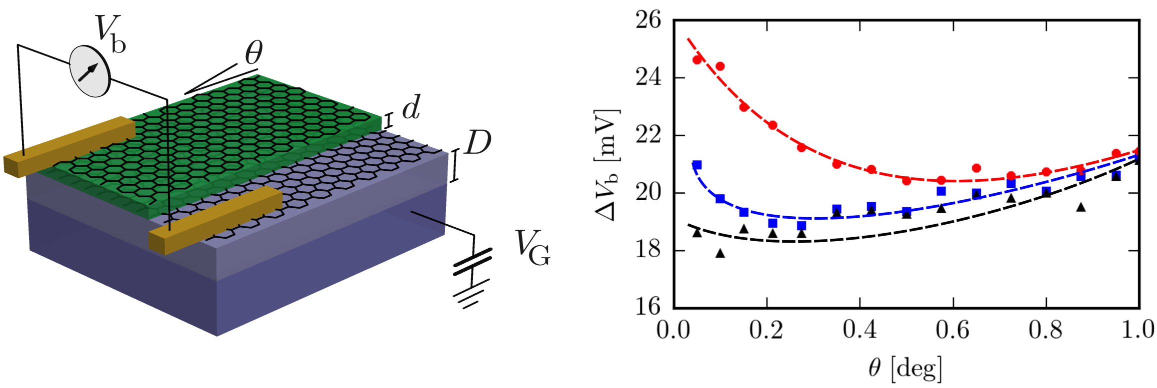
Figure

(a) **(b)**



(a) Tunneling heterostructure scheme. From bottom to top: a back gate (purple) maintained at the electric potential V_G, an insulating slab of thickness D, a bottom graphene layer, a hBN slab of thickness d (green), and a top graphene layer. The misalignment angle between the two graphene layers is θ. Ohmic contacts (gold regions) are deposited on the two graphene layers and an interlayer bias V_b is applied between the top and the bottom graphene layers. **(b)** Current density peak broadening as a function of the misalignment angle θ, at different values of temperature: T=10 K (black triangles), T=45 K (blue squares), and T=100 K (red circles). Quasiparticle lifetime effects (as the increasing broadening with temperature) emerge for small values of θ.